ARE HOG AND CATTLE FUTURES PRICES BIASED?

Carl R. Zulauf, Kimberly Coltman, and Scott H. Irwin
McCormick Professor of Agricultural Marketing and Policy, Ohio State University;
undergraduate student, Ohio State University; and
Professor, University of Illinois at Champaign-Urbana, respectively.

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Introduction

Hog and cattle farmers face a common managerial risk: during the months that pass between the decision to produce and the selling of finished animals, prices can change substantially. An expected profit when the decision to produce is made can turn into a loss when the finished animals are sold. Of course, an expected profit when the decision to produce is made can turn into an even larger profit when the finished animals are sold. However, the latter situation is a pleasant, as opposed to an unpleasant surprise.

One tool for managing the risk of negative consequences resulting from price changes is to hedge production using futures contracts. A key question in evaluating this marketing tool is whether futures markets provide unbiased forecasts of prices. If the forecasts are unbiased, then, for example, the July 1 price of the December fed cattle futures contract on average will equal the December 1 price of the December fed cattle futures contract. Stated alternatively, there is no tendency for futures prices to increase or decrease over the time a contract is traded. In contrast, if a bias exists, then futures prices on average will increase (or decrease) over the contract's trading time. Any bias in futures prices needs to be considered when making marketing decisions. For example, a

tendency for futures prices to increase argues for a wait-to-sell approach to marketing, assuming that everything else, such as risk, remains the same over the production period.

Previous studies suggest that live hog, fed cattle, and feeder cattle futures contracts have a bias or tendency for prices to increase. This study builds upon these studies by analyzing all three livestock futures contracts for bias over relevant production periods. Also analyzed for bias are the cattle and hog feeding spreads derived using the prices of live hog, fed cattle, feeder cattle, corn, and soybean meal futures contracts.

The next section contains a discussion of the data and analytical procedures. The reader may want to skip this section unless they are interested in these details. Results of the analysis follow, with conclusions and implications discussed in the final section.

Description of Data and Procedures

Trading of fed cattle, live hog, and feeder cattle futures contracts began at the Chicago Mercantile Exchange in 1964, 1966, and 1971, respectively. Trading volume was sparse until 1970 for fed cattle and live hogs, and until 1977 for feeder cattle. Beginning with 1970 or 1977, prices for the respective futures contract were obtained from a computer database compiled by Technical Tools, Inc. The analysis ends with the December 1996 contracts because in February 1997 the live hog contract was replaced with a lean hog contract.

Forecast periods of 4, 6, and 10 month periods were analyzed. Four months approximates a common feeding period for weaned pigs and for steers/heifers placed in a feedlot. Six months approximates the time from farrowing of a sow to selling her pigs as

hogs. It is also another common feeding period for steers/heifers. Ten months approximates the period between breeding a sow and selling her pigs as hogs.

The specific futures contracts and calendar periods used for the 4 and 6 month analyses are identified in Table 1. The calendar periods were selected to maximize the number of observations while avoiding an important analytical problem. To illustrate this problem, consider a 4-month period that ends in July and another one that ends in August. These two calendar periods overlap or have 3 months in common (May, June, and July). The change in price over the two 4-month periods is likely to be similar, raising a problem of double counting an observation. This double counting problem can be avoided by using non-overlapping periods, such as those given in Table 1.

The ending month of each forecast period was selected to coincide with an expiration (i.e., delivery or maturity) month for live hog and fed cattle futures contracts. Futures prices may become more volatile as a contract nears its last day of trading. Impact of this potential volatility is minimized by collecting futures prices for the first trading day of a month.

To illustrate the collection of data, consider fed cattle prices and a 4-month period that ends December 1. The 4 month earlier date is August 1. Closing prices of the December futures contract are collected on August 1 and December 1. The change in price over the August 1-to-December 1 period is calculated as December futures price on December 1 minus the December futures price on August 1. A positive sign means price increased, while a negative sign means price decreased. Note that, at the close of trading

on December 1, price of the April contract is collected as the initial price for the next 4-month forecast period.

Trading volume was light for fed cattle and, especially, feeder cattle contracts more than 6 months before expiration. Thus, the 10-month period was analyzed only for hogs. The same procedures were followed, except that, calendar months in the 10-month forecast period vary. Specifically, data were collected as follows: October 1, 1970 and August 1, 1971 prices of the August 1971 contract; August 1, 1971 and June 1, 1972 prices of the June 1972 contract; June 1, 1972 and April 1, 1973 prices of the April 1973 contract; and so forth.

When analyzing bias, no upward or downward trend in prices should exist. An obvious bias exists when prices trend up or down. Thus, it is much more important to find a bias over a period of time when no price trend exists.

Graphs of fed cattle, feeder cattle, and live hog futures prices were examined to identify periods with no trends (see Figures 1-5). Live hog futures prices trended upward from 1970 through 1975. Since early 1976, no obvious trend exists. Thus, the period from 1976 through 1996 is examined for hogs. The graphs for feeder cattle and fed cattle start with 1977, the first year of significant trading volume in feeder cattle futures. Both fed and feeder cattle prices trended upward from 1977 through 1980. Thereafter, no obvious trend exists. Thus, the 1981-1996 period was examined for cattle.

The futures-derived hog and cattle feeding spreads were calculated as follows:

Hogs: hog futures price ($/cwt.) - [corn futures price ($/bu.) • 3.884] - [meal futures price ($/ton) • 0.036)

Cattle: fed cattle futures price ($/cwt.) - [feeder cattle futures price ($/cwt.) • 0.5] - [corn futures price ($/bu.) • 5.625]

For hogs, the spread calculation implies that it takes 3.9 bushels of corn and 72 pounds of meal to produce 100 pounds of pork. This calculation assumes that the finished hog is sold at 250 pounds, that feed efficiency is 2.9 pounds of complete feed over the growing cycle, and that corn is the only source of energy. Professor David Meeker of Ohio State University's Animal Sciences Department supplied these numbers.

For cattle, the spread calculation assumes that a 600 pound feeder cattle is fed to 1200 pounds. Hence, a 0.5 factor is attached to feeder cattle futures prices. The factor on corn futures prices implies that it takes 5.625 bushels of corn to add 50 pounds of gain to the 600 pound feeder cattle. Professor Steven Boyle of Ohio State University's Animal Sciences Department supplied these numbers.

Results: Price Bias

From 1976 through 1996, the live hog futures price averaged $45.98/cwt at the beginning of the 4-month forecast period (i.e., forecast price). Average price at the end of the 4-month forecast period (i.e., ending price) was $47.03/cwt. Thus, futures prices increased an average of $1.05/cwt. over the 4-month forecast period. Hog futures price also increased on average over the 6-month forecast period ($1.91/cwt) and 10-month forecast period ($3.45/cwt). Additional analysis, which is available from the authors, found that the tendency for hog futures prices to increase existed over the subperiods of

1976-1985 and 1986-1996. These two subperiods, which divide the entire analysis period in half, provide a test for consistency.

As with hogs, feeder cattle and fed cattle prices also increased on average. The average increases for fed cattle were more than twice as large as for feeder cattle. Tendency for these futures prices to increase was consistent over the subperiods of 1981-1988 and 1989-1996. Again, this analysis is available from the authors.

Average changes in the hog and cattle feeding spreads closely follow the average changes in hog and fed cattle futures prices, respectively. For example, at the 4-month forecast period, average increase in live hog futures was $1.05/cwt, compared with $1.21/cwt for the hog feeding spread. Average increases were $1.67/cwt and $1.56/cwt, for fed cattle and the cattle feeding spread, respectively. These similarities are not surprising given that average price changes for corn and soybean meal futures were almost equally split between increases and decreases, and that live hogs and fed beef futures prices carry a much greater weight in the spread calculations than the other futures prices.

An indication of the economic importance of the bias observed for the hog feeding spread can be obtained by comparing this bias with the average returns earned above cash expenses, i.e., gross value of production minus cash expenses. The U.S. Department of Agriculture (USDA) reported this return annually for the U.S. over the analysis period. The net return above cash expenses to feeding hogs in the U.S. averaged $7.74/cwt for the 1976-1996 period. The average bias observed in the hog feeding spread over the 1976-1996 period at 4, 6, and 10 months was 16%, 26%, and 50% of this

average return, respectively. A similar analysis can not be conducted for the cattle feeding spread because USDA did not report cost of production data for all years over the analysis period.

An important marketing management tool is to test for statistical significance. A finding of statistical significance increases the confidence in the likelihood that historical differences will continue in the future. On the other hand, a finding of statistical insignificance increases the confidence that historical differences simply results from random chance.

Average change in live hog futures and the hog feeding spread at the 10-month forecast horizon was significantly different than zero at the commonly used 95% confidence level. Average change in fed cattle futures and the cattle feeding spread at the 4-month forecast period also was significantly greater than zero with 95% confidence. Stated alternatively, a less-than 5% probability exists that these four average increases were due to random chance. No average price changes for feeder cattle, corn, and soybean meal were statistically different from zero. For live hogs, fed cattle, and the two feeding spreads, the number of statistically significant average changes is greater than the number expected from random chance, despite the fact that the small number of observations reduces the likelihood of finding statistical significance.

A striking difference exists in the behavior of crop and livestock futures prices. This difference can be summarized by comparing the average confidence levels associated with the statistical test: 92% for the hog feeding spread, 87% for hogs, 51%

for corn, and 18% for meal. Similarly, the average confidence levels are 97% for the cattle feeding spread, 94% for fed cattle, 56% for feeder cattle, and 39% for corn.

Results: Risk Reduction

The bias toward increases in hog and fed cattle futures prices and feeding spreads reduce the incentive to forward market expected production. However, forward marketing may reduce risk. To examine this potential, standard deviation of prices and spreads is calculated for the initial and ending dates of each forecast horizon. Standard deviation is a commonly used measure of risk, with a higher standard deviation implying a higher level of risk. It should be noted that this analysis provides only an indication of risk reduction potential because risk should be calculated over the entire forecast (i.e., production) period, not just at the beginning and ending dates. Nevertheless, this simple analysis can provide insights into forward marketing's potential to reduce risk.

Results are presented in table 3. Theoretical arguments imply that standard deviation should be lower for a forecast price than for prices observed at the end of the forecast period. This theoretical argument was supported in all cases. Furthermore, standard deviation of the forecast price decreased as the forecast period increased in length. For example, standard deviation of the forecast price for hogs decreased from \$6.60/cwt at 4 months, to \$6.39/cwt at 6 months, to \$4.94/cwt at 10 months. In comparison, standard deviation of the ending price ranged from \$7.04/cwt. to \$7.72/cwt.

Standard deviations of the forecast and ending prices (spreads) can be tested for statistical difference by using the F-ratio test. At the 95% confidence level, 4 of the 5 F-

ratio tests for the feeding spreads found that the standard deviation was significantly larger at the end of the forecast period than at the beginning of the forecast period. Only one other F-test was statistically significant: live hogs at the 10-month horizon.

Summary and Conclusions

This analysis finds a strong bias for the price of live hog, fed cattle and feeder cattle futures contracts to increase over relevant production periods. This bias also is found for the hog and cattle feeding spreads derived using futures prices for these livestock, corn, and soybean meal. In a striking contrast, no bias is found for corn and soybean meal futures prices.

The analysis suggests that forward contracting may reduce the risk faced by livestock producers, especially when the feeding spread is hedged. The cost of reducing this risk includes the lower returns to feeding resulting from the above-mentioned bias for the feeding spread to increase. This trade-off is consistent with the well-documented financial rule that higher risk must be compensated with higher returns. Whether an individual producer finds the cost of reducing the risk of livestock feeding high depends on the preference for risk of the producer. Thus, it can not be answered in general. However, the tradeoff between lower profit, resulting in part from the price bias, and higher risk should be consciously considered by each livestock producer as part of their management plan, especially in light of the recent low prices in the hog market.

We close by raising two related questions: why has a bias for livestock futures prices to increase existed, especially given the lack of bias in crop futures prices?; and

why has this bias persisted for so long? One explanation is that the bias is economically irrational. This explanation raises the question, why haven't speculators and hedgers bid away the bias in their search for profits? A second explanation is that the bias is a payment for some type of risk. This explanation raises the question, what is the risk?

Our view is that the risk explanation seems more plausible. It is easy to trade futures contracts and futures markets as an institution posses a high degree of trading efficiency. However, it is not clear what the risk is. To us, the general nature of production, financial, and management risks do not appear to differ that much between crops and livestock. Maybe the bias exists because of some currently unrecognized or underappreciated risk in raising livestock. Whatever the answer, it is important because its identification most likely will allow livestock producers to better manage their operations to maximize returns while minimizing risks.

Table 1. Calendar Months and Futures Contracts Used to Analyze Price Bias at the 4-Month and 6-Month Forecast Periods, U.S., 1976-1996.

Forecast Period	Months in Forecast Period	Futures Contract by Commodity				
		Live Hogs	Fed Cattle	Feeder Cattle	Corn	Soybean Meal
4 Month	Dec. 1 - Apr. 1	Apr.	Apr.	Apr.	May	May
	Apr. 1 - Aug. 1	Aug.	Aug.	Aug.	Sept.	Aug.
	Aug. 1 - Dec. 1	Dec.	Dec.	Mar.	Dec.	Dec.
6 Month	Dec. 1 - Jun. 1	June	June	Aug.	July	July
	Jun. 1 - Dec. 1	Dec.	Dec.	Mar.	Dec.	Dec.

Table 2. Forecast Bias of Corn, Soybean Meal, Live Hog, Feeder Cattle, and Fed Cattle Futures Prices, and Futures-Derived Hog and Cattle Feeding Spreads, 1976-1996.

Statistics by Length of Forecast Period	Commodity by Period of Analysis							
	1976 - 1996				1981 - 1996			
	Corn $/bu.	Meal $/ton	Hogs $/cwt	Hog Spread $/cwt.	Corn $/bu.	Feeder Cattle $/cwt.	Fed Cattle $/cwt.	Cattle Spread $/cwt.
4-Month								
Forecast Price	2.65	188.85	45.98	28.88	2.63	72.77	67.50	16.33
Ending Price	2.62	187.84	47.03	30.08	2.59	73.40	69.17	17.89
Average Change	-0.03	-1.01	1.05	1.21	-0.04	0.62	1.67	1.56
% Confidence Level	54.6	21.5	79.1	86.4	53.0	67.8	97.9*	99.8*
Observations	62	62	62	62	47	47	47	47
6-Month								
Forecast Price	2.68	190.36	46.87	29.61	2.64	71.72	66.50	15.82
Ending Price	2.65	190.80	48.78	31.63	2.61	72.22	68.14	17.34
Average Change	-0.03	0.44	1.91	2.02	-0.02	0.51	1.64	1.52
% Confidence Level	34.7	6.9	85.6	91.1	24.0	43.6	90.8	93.6
Observations	41	41	41	41	31	31	31	31
10-Month								
Forecast Price	2.72	193.16	46.26	28.75				
Ending Price	2.63	190.90	49.71	32.61				
Average Change	0.06	-2.26	3.46	3.86				
% Confidence Level	64.5	25.5	96.3*	97.9*				
Observations	24	24	24	24				

* indicates statistical significance

Source: original calculation

Table 3. Comparison of Variation at Initial and Ending Dates of Forecast Periods, Corn, Soybean Meal, Live Hog, Feeder Cattle, and Fed Cattle Futures Prices, and Futures-Derived Hog and Cattle Feeding Spreads, 1976-1996.

Statistics by Length of Forecast Period	Commodity by Period of Analysis							
	1976 - 1996				1981 - 1996			
	Corn $/bu.	Meal $/ton	Hogs $/cwt	Hog Spread $/cwt.	Corn $/bu.	Feeder Cattle $/cwt.	Fed Cattle $/cwt.	Cattle Spread $/cwt.
4-Month								
Standard Deviation:								
Forecast Price	0.49	31.66	6.60	6.33	0.49	8.01	5.79	2.93
Ending Price	0.53	32.30	7.08	7.69	0.53	9.03	6.63	4.07
% Confidence Level	74.8	56.2	70.9	93.5*	82.6	76.7	82.0	98.9*
6-Month								
Standard Deviation:								
Forecast Price	0.45	28.62	6.39	5.60	0.43	7.64	5.63	2.41
Ending Price	0.55	32.69	7.72	7.90	0.56	8.60	5.94	4.43
% Confidence Level	89.8	79.8	88.2	98.4*	92.3	74.0	61.5	99.9*
10-Month								
Standard Deviation:								
Forecast Price	0.42	23.46	4.94	4.25				
Ending Price	0.51	32.11	7.04	7.63				
% Confidence Level	79.9	93.0	95.1*	99.7*				

* indicates statistical significance

Source: original calculation

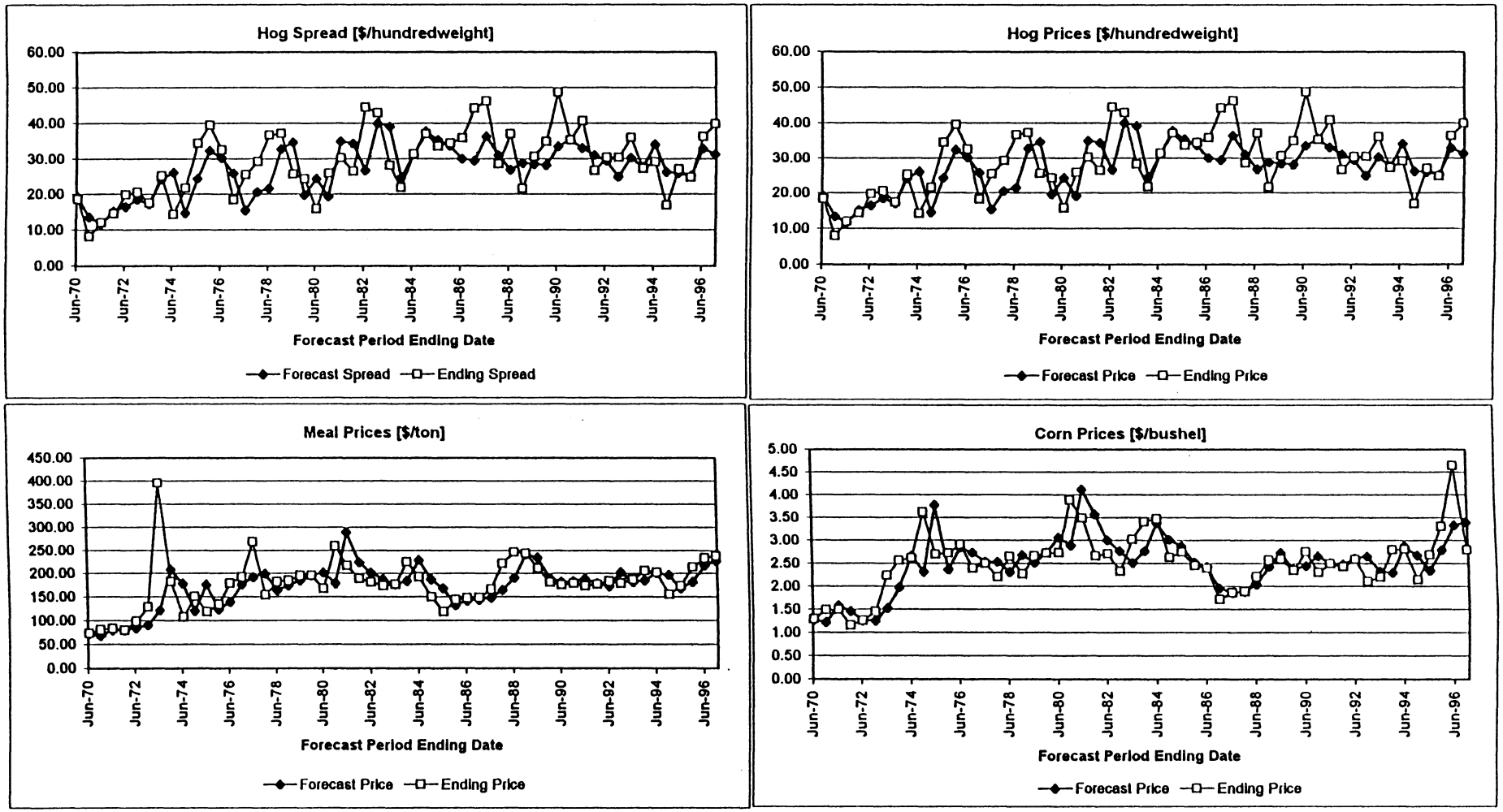

Figure 2. Futures-Derived Hog Feeding Spread and Component Futures Prices, 6 month forecast period, 1970-1996

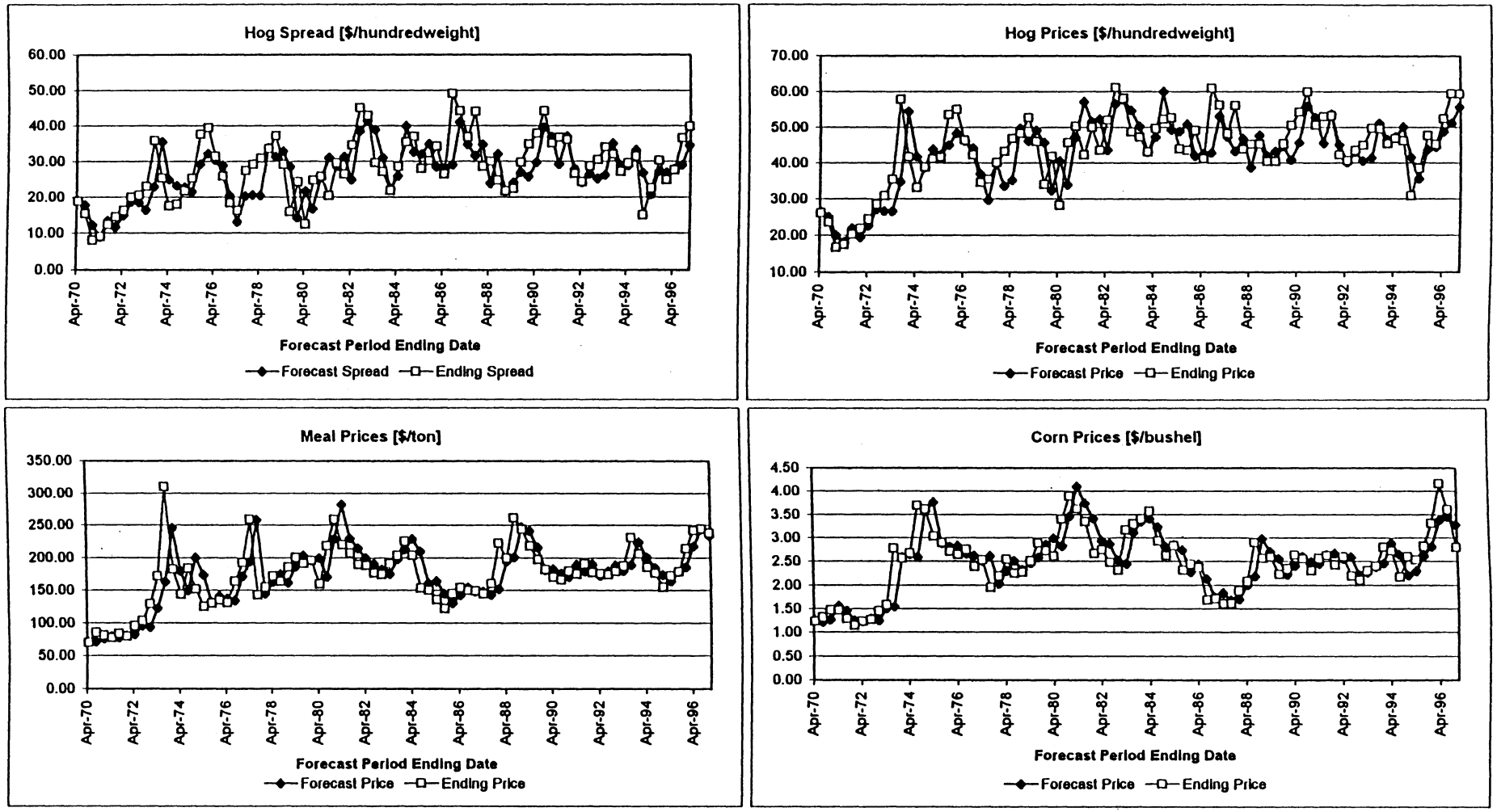

Figure 1. Futures-Derived Hog Feeding Spread and Component Futures Prices, 4 month forecast period, 1970-1996

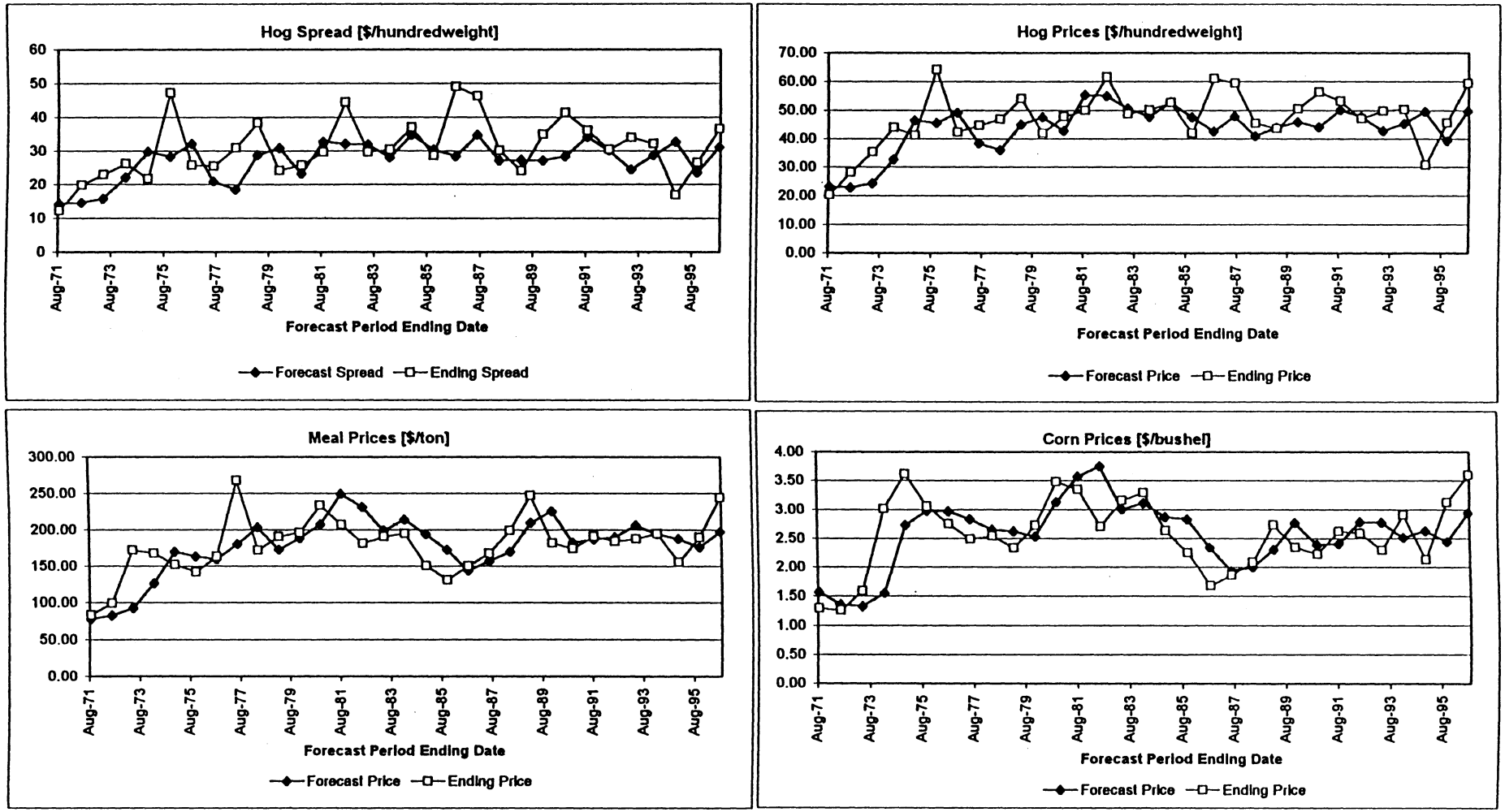

Figure 3. Futures-Derived Hog Feeding Spread and Component Futures Prices, 10 month forecast period, 1970-1996

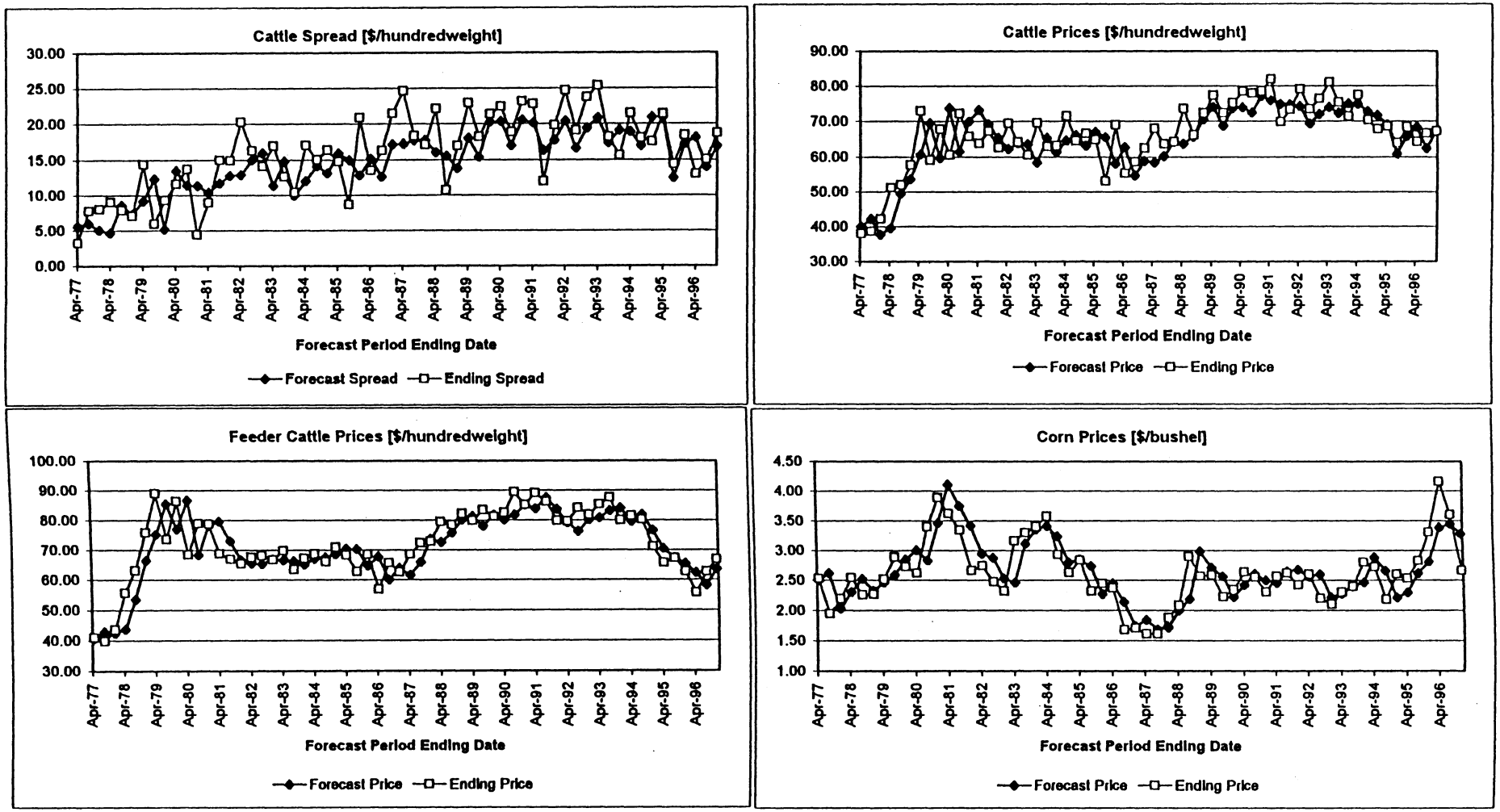

Figure 4. Futures-Derived Cattle Feeding Spread and Component Futures Prices, 4 month forecast period, 1977-1996

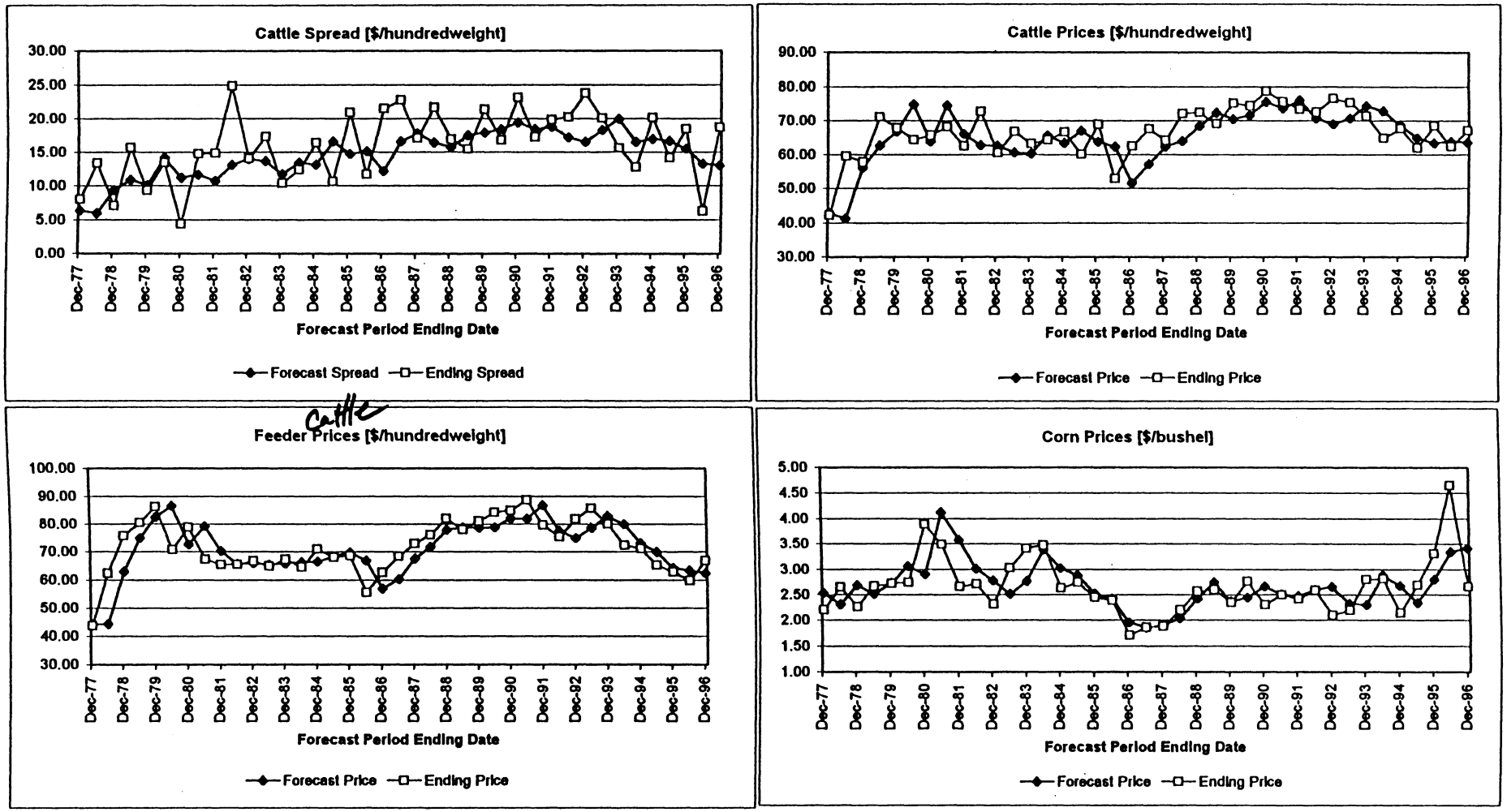

Figure 5. Futures-Derived Cattle Feeding Spread and Component Futures Prices, 6 month forecast period, 1977-1996

Table 4. Forecast Bias of Corn, Soybean Meal, and Live Hog Futures Prices, and the Futures-Derived Hog Feeding Spread, 1976-1996.

Statistics by Length of Forecast Period	Commodity by Period of Analysis											
	1976-1996				1976-1985				1986-1996			
	Corn $/bu.	Meal $/ton	Hogs $/cwt.	Spread $/cwt.	Corn $/bu.	Meal $/ton	Hogs $/cwt.	Spread $/cwt.	Corn $/bu.	Meal $/ton	Hogs $/cwt.	Spread $/cwt.
4-Month												
Forecast Price	2.65	188.85	45.98	28.88	2.84	188.84	45.87	28.03	2.48	188.86	46.10	29.67
Ending Price	2.62	187.84	47.03	30.08	2.77	183.26	45.63	28.27	2.48	192.14	48.35	31.78
Average Change	-0.03	-1.01	1.05	1.21	-0.07	-5.58	-0.24	0.24	0.01	3.28	2.25	2.11
% Confidence Level	54.6	21.5	79.1	86.4	73.6	61.1	14.4	15.8	7.5	60.3	96.8*	94.2
Observations	62	62	62	62	30	30	30	30	32	32	32	32
6-Month												
Forecast Price	2.68	190.36	46.87	29.61	2.85	190.38	47.10	29.16	2.51	190.34	46.66	30.04
Ending Price	2.65	190.80	48.78	31.63	2.77	186.08	47.66	30.21	2.54	195.30	49.85	32.97
Average Change	-0.03	0.44	1.91	2.02	-0.09	-4.30	0.56	1.06	0.02	4.96	3.20	2.93
% Confidence Level	34.7	6.9	85.6	91.1	60.1	36.8	21.4	43.3	18.6	65.1	94.5	94.0
Observations	41	41	41	41	20	20	20	20	21	21	21	21
10-Month												
Forecast Price	2.72	193.16	46.26	28.75	2.94	196.25	46.86	28.38	2.49	190.08	45.65	29.13
Ending Price	2.63	190.90	49.71	32.61	2.72	188.68	50.13	32.77	2.55	193.12	49.29	32.45
Average Change	0.06	-2.26	3.46	3.86	-0.22	-7.57	3.27	4.39	0.05	3.04	3.64	3.33
% Confidence Level	64.5	25.5	96.3*	97.9*	90.6	47.7	84.2	91.8	32.0	29.5	85.0	84.1
Observations	24	24	24	24	12	12	12	12	12	12	12	12

* indicates statistical significance

Source: original calculations

Table 5. Forecast Bias of Corn, Feeder Cattle, and Fed Cattle Futures Prices, and the Futures-Derived Cattle Feeding Spread, 1981-1996.

Statistics by Length of Forecast Period	Commodity by Period of Analysis: 1981-1996 Corn $/bu.	1981-1996 Feeder Cattle $/cwt.	1981-1996 Fed Cattle $/cwt.	1981-1996 Spread $/cwt.	1981-1988 Corn $/bu.	1981-1988 Feeder Cattle $/cwt.	1981-1988 Fed Cattle $/cwt.	1981-1988 Spread $/cwt.	1989-1996 Corn $/bu.	1989-1996 Feeder Cattle $/cwt.	1989-1996 Fed Cattle $/cwt.	1989-1996 Spread $/cwt.
4-Month												
Forecast Price	2.63	72.77	67.50	16.33	2.64	68.67	63.70	14.53	2.62	77.06	71.47	18.20
Ending Price	2.59	73.40	69.17	17.89	2.55	69.17	65.48	16.55	2.64	77.80	73.03	19.28
Average Change	-0.04	0.62	1.67	1.56	-0.09	0.50	1.79	2.02	0.02	0.75	1.56	1.08
% Confidence Level	53.0	67.8	97.9*	99.8*	77.5	41.9	85.5	98.3*	20.6	59.8	95.2*	93.5
Observations	47	47	47	47	24	24	24	24	23	23	23	23
6-Month												
Forecast Price	2.64	71.72	66.50	15.82	2.62	67.85	63.21	14.57	2.66	75.84	70.02	17.15
Ending Price	2.61	72.22	68.14	17.34	2.54	68.63	65.42	16.81	2.69	76.06	71.05	17.91
Average Change	-0.02	0.51	1.64	1.52	-0.07	0.77	2.21	2.24	0.03	0.22	1.03	0.76
% Confidence Level	24.0	43.6	90.8	93.6	56.9	47.6	82.6	92.0	16.7	13.2	64.9	52.1
Observations	31	31	31	31	16	16	16	16	15	15	15	15

* indicates statistical significance

Source: original calculations